

CLAIM AMENDMENTS

1. (Original) A computer controlled laser machine tool comprising in combination:
said laser machine tool having a working zone smaller than the workpiece processed such that said workpiece is indexed through the work zone for processing; and
said laser machine tool having an image sensor mounted to focus on a target on the workpiece.
2. (Original) The laser machine tool of claim 1 wherein the image sensor determines position information for at least two reference targets on the workpiece.
3. (Original) The laser machine tool of claim 1 wherein said machine tool is adapted for any one or any combination of cutting, marking or welding.
4. (Original) The laser machine tool of claim 1 wherein said machine tool has at least three mutually perpendicular servo controlled axes, one of the axes being adjusted to establish the focus of the image sensor, at least one other axis being adjusted to position the image sensor over targets on the workpiece.
5. (Original) The laser machine tool of claim 2 wherein said image sensor determines the position of the at least two targets on the workpiece and wherein the image sensor sends information on the position of said targets to a computer of the computer controlled laser machine tool which responds by determining position errors and adjusting a reference coordinate system of said workhead guidance system to correct for said position errors.
6. (Original) The laser machine tool of claim 5 wherein the image sensor is adapted to check and maintain registration of a workhead guidance system relative to said workpiece when said workpiece is indexed through the work zone a plurality of indexes.
7. (Original) The laser machine tool of claim 1 wherein the image sensor is adapted to check and maintain registration of a workhead guidance system relative to said workpiece when said workpiece is indexed through the work zone a plurality of indexes.

8. (Original) A computer controlled laser machine tool adapted for any one of or any combination of cutting marking or welding a workpiece, said laser machine tool having a workhead, said laser machine tool having a work zone smaller than the workpiece processed such that said workpiece is indexed through the work zone for processing and comprising in combination:

said laser machine tool having an indexable work support for carrying a workpiece;

said machine tool having an image sensor mounted to image targets on the workpiece;

said image sensor used to check and maintain registration of a workhead guidance system relative to said workpiece when said workpiece is indexed through said work zone; and

said image sensor checking registration of said workpiece by measuring the position of at least two targets on said workpiece before and after the workpiece is indexed through the work zone.

9. (Original) The laser machine tool of claim 8 wherein the image sensor sends data on the position of said at least two targets to a computer of the computer controlled laser machine tool which responds by determining position errors, said position errors used to adjust a reference coordinate system of said workhead guidance system to correct for said position errors.

10. (Original) The laser machine tool of claim 8 wherein said machine tool has at least three mutually perpendicular servo controlled axes.

11. (Original) The laser machine tool of claim 8 wherein said targets are etched into the surface of said workpiece by said laser machine tool.

12. (Original) The laser machine tool of claim 8 wherein said targets are affixed to the surface of said workpiece.

13. (Original) The laser machine tool of claim 8 wherein the said targets are affixed to the surface of said workpiece relative to registration marks etched into said workpiece by said laser machine tool.

14. (Original) The laser machine tool of claim 8 wherein said image sensor has integrated measurement tools capable of determining the center of a plurality of target shapes.

15. (Original) The laser machine tool of claim 8 wherein said machine tool includes an apparatus to blow residue off of said target prior to capturing an image of said target.

16. (Original) The laser machine tool of claim 8 wherein corrections of measured workhead to workpiece registration errors are made by rotating and/or shifting the reference coordinate system.

17. (Original) The laser machine tool of claim 8 wherein said targets are printed having a symmetrical, non-reflective, target image on a contrasting background and are adhesive backed.

18. (Original) The laser machine tool of claim 8 wherein said targets are printed having a symmetrical, non-reflective, target image on a contrasting background and are magnetic.

19. (Original) The laser machine tool of claim 8 wherein said image sensor is mounted on said workhead, said workhead having a servo controlled axis that drives a cutting head and a nozzle along a Z-axis, said cutting head having a control apparatus to automatically control the nozzle-to-workpiece standoff distance and to automatically set the image sensor lens-to-workpiece working distance such that the image sensor is automatically focused.

20. (Original) The laser machine tool of claim 8 wherein said image sensor is mounted in a housing, said housing being mounted on said workhead, said housing having a lens and a nozzle mounted proximate to said lens to provide a shield gas flow to keep said lens clean.

21. (Original) The laser machine tool of claim 8 wherein said image sensor is mounted in a housing, said housing mounted on said workhead, said housing having a lens, said lens provided with a shutter to keep said lens clean.

22. (Original) The laser machine tool of claim 21 wherein said shutter is driven via a rotary solenoid.

23. (Original) The laser machine tool if claim 21 wherein said shutter is driven via a pneumatic actuator.

24. (Original) A computer controlled laser machine tool adapted for cutting and marking a workpiece, said laser machine tool having a workhead, said laser machine tool having a work zone smaller than the workpiece processed such that said workpiece is indexed through said work zone for processing, said laser machine tool having an indexable work support carrying a workpiece and comprising in combination:

said machine tool having an image sensor positioned to image a target on the workpiece;

said image sensor mounted on said workhead, said workhead having a servo controlled axis that drives a cutting head and a nozzle along a Z-axis, said cutting head adapted with a control apparatus to automatically control the nozzle to workpiece standoff distance and to automatically set the image sensor lens to workpiece working distance such that the image sensor is automatically focused;

said image sensor used to check and maintain registration of a workhead guidance system relative to said workpiece when said workpiece is indexed through said work zone;

said image sensor checking registration of said workpiece by measuring the position of two targets on said workpiece before and after the workpiece is indexed through the work zone;

said image sensor producing target position information as a result of checking registration, a computer of said computer controlled laser machine tool operating on said target position information to determine position errors;

a computer of said computer controlled machine tool using said position errors to produce corrections; and

wherein said corrections of determined position errors are made by rotating and/or shifting the reference coordinate system.

25. (Original) The laser machine tool of claim 24 wherein said machine tool has at least three mutually perpendicular servo controlled axes.

26. (Original) The laser machine tool of claim 24 wherein said targets are etched into the surface of said workpiece by said laser machine tool.

27. (Original) The laser machine tool of claim 24 wherein said targets are affixed to the surface of said workpiece.

28. (Original) The laser machine tool of claim 24 wherein the said targets are affixed to the surface of said workpiece relative to registration marks etched into said workpiece by said laser machine tool.

29. (Original) The laser machine tool of claim 24 wherein said machine tool includes an apparatus to blow residue off of said target prior to capturing an image of said target.

30. (Original) The laser machine tool of claim 24 wherein said image sensor has integrated measurement tools capable of determining the center of a plurality of target shapes.

31. (Original) The laser machine tool of claim 24 wherein said targets are printed having a symmetrical, non-reflective, target image on a contrasting background and are adhesive backed.

32. (Original) The laser machine tool of claim 24 wherein said targets are printed having a symmetrical, non-reflective, target image on a contrasting background and are magnetic.

33. (Original) The laser machine tool of claim 24 wherein said image sensor is mounted in a housing, said housing being mounted on said workhead, said housing having a lens and a nozzle mounted proximate to said lens to provide a shield gas flow to keep said lens clean.

34. (Original) The laser machine tool of claim 24 wherein said image sensor is mounted in a housing, said housing being mounted on said workhead, said housing having a lens and said lens having a shutter to keep said lens clean.

35. (Original) The laser machine tool of claim 34 wherein said shutter is driven via a rotary solenoid.

36. (Original) The laser machine tool if claim 34 wherein said shutter is driven via a pneumatic actuator.

37. (Original) The laser machine tool of claim 24 wherein registration of workhead to workpiece is checked comparing with set error limits.

38. (Original) A computer controlled laser machine tool adapted for any one of or any combination of cutting marking or welding a workpiece, said laser machine tool having a workhead, said laser machine tool having a work zone smaller than the workpiece processed such that said workpiece is indexed through the work zone for processing and comprising in combination:

said laser machine tool having an indexable work support configured for carrying a workpiece;

said machine tool having an image sensor mounted to focus on a target on the workpiece;

said image sensor configured to check and maintain registration of a workhead guidance system relative to said workpiece when said workpiece is indexed through said work zone; and

said image sensor checking registration of said workpiece without requiring holes to be cut into the workpiece.

39. (Original) A method of maintaining registration of a workhead guidance system in a computer controlled laser machine tool, the laser machine tool having a workhead operable over a work zone smaller than the workpiece processed such that the workpiece is indexed through the work zone for processing, the method comprising in combination:

providing the workhead with an image sensor mounted to image a target on the workpiece;

utilizing the image sensor to image at least two targets on the workpiece when the workpiece is in a first position and store target position information in computer memory, after indexing the workpiece using the image sensor to image said at least two targets and store post index target information in computer memory;

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utilizing the target position information to determine position errors; and
using the determined position error information to adjust the registration of a
workhead guidance system relative to the workpiece thereby to maintain registration.